10.

Civil Defense

LITTLE HARBOR REPORT

A Report to the Atomic Energy Commission
by a
Committee of the National Academy of Sciences

6764
12-1-83

3806

RR#262

CIVIL DEFENSE
Little Harbor Report

A Report to the Atomic Energy Commission
by a
Committee of the National Academy of Sciences

1969

U.S. ATOMIC ENERGY COMMISSION / Division of Technical Information

Foreword

The question of whether our nation should mount and maintain an effective civil defense against major nuclear attack has been illuminated by a variety of studies conducted both within and without our federal government. Opinions of highly qualified specialists are divided on the wisdom of committing substantial national resources in an effort to reduce the loss of life and the essential functions of our society.

The National Academy of Sciences has responded to requests of the government to assist those federal agencies which are charged with the responsibility for the national defense. In particular, it has enlisted the services of a dedicated group of individuals who have attempted to bring up to date the findings of the Project Harbor Study of 1963. The results of this effort, reported in the following pages, reflect the group's belief in civil defense as a necessary complement to our military defense. The decision as to whether the actions and programs suggested should be taken involves judgments of a complex kind which are only in part scientific or technical in nature. It is our hope that this report will aid those persons concerned with such decisions in formulating their opinions.

Whatever the decision, the Academy and the national government are indebted to Dr. Wigner and his associates for their useful contribution to these difficult problems.

Frederick Seitz
National Academy of Sciences

Washington, D. C.
May 1968

Preface

In March 1967, at the suggestion of the Director of Defense Research and Engineering, the Atomic Energy Commission requested the National Academy of Sciences to review and update the Project Harbor Study on Civil Defense. The Harbor Study was sponsored by the Office of Civil Defense and carried out under the auspices of the National Academy of Sciences in the summer of 1963. About 60 scientists (both natural and behavioral) and engineers participated in the six-week study. The final report came to over 600 typewritten pages; its distribution was very limited. A summary report, NAS-1237, was issued in 1964 and had a wider distribution.

I had the honor of assembling the group to be entrusted with reviewing and updating the 1963 report, and I wish to express my gratitude to my collaborators for the sincerity of their efforts to grapple with the many thorny problems of civil defense and for the unstinted nature of their collaboration. I am especially grateful to Richard Park of the National Academy of Sciences and L. J. Deal of the U. S. Atomic Energy Commission for their constant and unflagging help.

The members of the study group were:

Harold L. Brode, Physics Division, The RAND Corporation, an expert on modern weapons and their effects.

Lee Christie, System Development Corporation, social scientist.

L. J. Deal, Division of Biology and Medicine, U. S. Atomic Energy Commission.

William J. Hall, Department of Civil Engineering, the University of Illinois, an expert in structural design and the dynamics of blast.

Harold A. Knapp, Institute for Defense Analyses, defense analyst.

William Osburn, Division of Biology and Medicine, U. S. Atomic Energy Commission, ecologist.

Richard Park, National Academy of Sciences.

John H. Rust, Department of Pharmacology, the University of Chicago, interested in problems of agriculture, health, and medicine, including biological warfare.

Sidney G. Winter, The RAND Corporation, economist. His interest in the problems of economic recovery antedates even the original Harbor Report.

John P. Witherspoon, Oak Ridge National Laboratory, ecologist.

Stephen B. Withey, Institute for Social Research, the University of Michigan, social psychologist. His principal research area is human behavior and public attitudes.

With twelve participants of very different backgrounds collaborating to assess the promise and the problems of civil defense, complete unanimity on every point was not to be expected. We have tried to indicate areas of disagreement in the text.

The study took place at the Oak Ridge National Laboratory from May 23 to June 3, 1967. We are indebted to the Director of the Laboratory, Alvin M. Weinberg, for his interest and for having extended the hospitality and many other courtesies of the Laboratory to us. The Civil Defense Research Project, under the direction of James C. Bresee, made available their library, administrative services, and other facilities. They also gave us a great deal of technical assistance. We are particularly indebted to Dr. Bresee, to Conrad Chester, and to Richard Uher for their help on many difficult questions.

Other consultants and observers were:

Milton Leitenberg, St. Louis Committee for Nuclear Information, represented the point of view opposing civil defense measures.

Julian Levi, Department of Social Sciences, the University of Chicago, advised on problems of urban development.

D. L. Narver, Jr., Holmes and Narver, Inc., advised on the effect of blast from nuclear explosions on structures and construction costs.

Lewis V. Spencer, Department of Physics, Ottawa (Kansas) University, advised on the thinking of the Advisory Committee on Civil Defense of the National Academy of Sciences.

Harry R. Woltman, Planning Research Corporation, advised on defense planning and urban development.

Briefings on the thinking and philosophy of the Department of Defense were given by:

Thomas S. Schreiber, Office of the Director, Defense Research and Engineering.

Robert Rosenthal, Office of the Director, Defense Research and Engineering.

Ivan Selin, Deputy Assistant Secretary of Defense (Strategic Programs).

The (then Acting) Director of the Office of Civil Defense, Joseph Romm; his Assistant Director of Civil Defense for Research, Walmer E. Strope; and his Deputy Assistant Director for Operations, William E. Crockett, briefed us personally on the policies, problems, and accomplishments of their office. J. M. Googin of the Oak Ridge Y-12 facility spoke to us twice on modern weapons as influenced particularly by the advent of the antiballistic defense installations in the USSR. We are sincerely grateful to all our consultants and advisors for their generous assistance and their patience and willingness in answering our questions.

Eugene P. Wigner
Director

Contents

Introduction and Summary

In reevaluating and updating the conclusions of the original Harbor Study, the committee did not consider the consequences of all the new circumstances one by one. Rather, our study—known among the participants as the Little Harbor Study—attempted to take a fresh look at the problems, possibilities, and reasons for civil defense. Naturally, the fresh look could not disregard the changed circumstances and these, as well as some changes in our evaluation of the old circumstances, are reflected in several modifications in emphasis and in some modifications in substance of the earlier report. In some instances we felt that the conclusions of the original report had become so generally accepted that they need not be repeated.

On the whole we were surprised by the continued validity of most of the recommendations of the earlier report. The following new or revised recommendations and conclusions reflect the most important changes that have occurred in the situation or in our thinking:

1. We now propose that most of the civil defense personnel who may be needed in an emergency not be fulltime civil defense officers in peacetime. Rather, they should be personnel from state and local organizations, such as police and fire departments, who have responsibilities for dealing with peacetime emergencies. These persons should receive thorough training, enabling them to function effectively in wartime. This proposal is a significant departure from the civil-defense-cadre concept of the original Harbor Study and applies the dual-use principle to the manpower problem. It is further discussed in the chapters on Immediate Survival and Education and Training.

2. A larger number of people should be made aware of the problems that would arise in a nuclear war. In particular, the basic training of recruits to our armed forces should include instruction on the emergency operations necessary in case of a nuclear attack. The people so trained would substitute for, or at least complement, the Civilian Reserve Corps recommended by the original Harbor Report. This recommendation is further discussed in the chapter on Education and Training.
3. The significance of the relations between civil, or passive, defense and active defense, such as antiballistic missiles, is becoming increasingly apparent. It was not possible to study these relations in detail, much less to determine the combination of the two systems that would be most effective. However, the undertaking of such a study by a competent group of reasonable size is strongly recommended. (See, for instance, the Changes in Strategic Outlook chapter.) This recommendation is particularly appropriate in view of the recent decision to install a "thin" antiballistic defense.

All participants seemed to agree that the acquisition of a strong civil defense would require a large, well-coordinated, and many-faceted effort. It would also involve great expenditures. In a large-scale war, however, it would save an untold number of lives, would improve the morale of the people, and would reduce the severity of the aftereffects of the war. Most of us also think that, as an evidence of national resolve, a strong civil defense program would render the tactic of nuclear blackmail less promising. This will be discussed further in the Threat chapter. Lesser efforts toward civil defense would have similar effects but of lesser magnitude.

Changes in Strategic Outlook

Listed here are the most important changes in the military situation and some of the changes in the political attitudes which have occurred since the original Harbor Study was undertaken and which are likely to affect the problems of civil defense. As mentioned in the Introduction and Summary, the changes were not the basis for our deliberations; however, they may be useful when reviewing our new conclusions.

1. Confidence in antiballistic defense systems is increasing in the United States and the USSR, and both countries are currently installing some such defense. The significance of this development is emphasized by the way it has compelled our military planners to undertake extensive alterations of the armaments that comprise our retaliatory forces.
2. The interaction between active and passive defense, that is, between antiballistic missiles (ABM) and civil defense, was only hinted at in the Harbor Report. Even now the connection is far from being well understood or evaluated with any degree of completeness. A complete evaluation would be of highest importance. Present evidence indicates that expenditures on civil defense would be at least as effective in saving lives as expenditures on presently conceived ABM systems, particularly at low levels of expenditure. However, active defense not only can protect the lives of people but can also enhance the nation's ability to recover from a war by limiting damage to buildings and industrial installations. In addition, the installation of an ABM system may force the opponent to alter his offensive weapons or his targets. The total weight of the ballistic

missile capability of the United States is being reduced by the replacement of single by multiple warheads, undertaken to counter the Russian ABM. Paul Nitze, Deputy Secretary of Defense, in his Congressional testimony (Nov. 7, 1967) gave a perhaps extreme example in which the total explosive power carried by a missile (and hence the total fallout created) would be reduced by a factor of 20. In his example, the area covered by any given overpressure is reduced to 29%. A similar reduction of the total weight of the attack against the United States would render our civil defense measures much more effective.

3. The importance of the problems of long-term survival and recovery after a nuclear war are increasingly recognized. Some of the questions that demand answers are: How should the emphasis of preparedness programs be apportioned between the problems of recovery and those of immediate survival? How would rate and assurance of recovery be affected by the distribution of the survivors in age and occupation? How would it be affected by the level of surviving industrial capacity? How long would it take to rebuild the country after a nuclear war? The answers will depend, naturally, on the magnitude of the attack, its aims and success, and the character and extent of the advance preparations to alleviate the consequences of any nuclear war. These questions will be discussed in the Recovery chapter more fully than they could be discussed in the original Harbor Report or its Summary.

4. Since the federal activities related to urban affairs are concentrated in the Department of Housing and Urban Development (HUD), this department is the natural authority responsible for the passive defense of the cities. New construction and urban renewal projects could incorporate shelters as such or as dual-use components. Regardless of the choice, the installation of shelters would increase the total cost of the renewal project much less than would be the cost of an independent project of shelter construction. Current and tentative urban renewal plans should be examined in detail to evaluate the passive defense resources which they would create and to identify the components that could be converted to blast-resistant shelters of high quality. Advantages to both sides would be expected to

accrue from an interchange of ideas between those parties concerned with passive defense and those interested in urban development. Urban planners may well keep in mind that nuclear weapons exist and that they are not likely to be abolished in the near future. New concepts and practices developed in the HUD programs may also contribute to the solution of some of the problems of postattack recovery.

The HUD and the General Services Administration could provide example and leadership for private builders to incorporate shelters into new buildings or at least to make later conversion into shelters possible. With such leadership and perhaps with other appropriate incentives, private construction, which will continue to exceed public construction by a wide margin, could add substantially to the realization of an effective passive defense.

5. The doctrine of "assured retaliation" has continued to gain importance in the past few years and appears to be a basic Department of Defense policy. This doctrine is, nevertheless, dependent on certain assumptions, some of which may be questioned now, while the validity of others may be impaired in the future. In particular, the doctrine depends on the full understanding and acceptance by the adversaries. Any doubt, justified or not, on the part of the adversary could lead to tragic consequences.

6. With respect to China, the doctrine of assured retaliation has been questioned in the Department of Defense. Underestimating Chinese nuclear war capabilities or the purpose and determination of the rulers of China could be catastrophic.

7. The absence of a true defense in the United States, i.e., active or passive protection rather than retaliation, may provide an added incentive for hostile nations to acquire nuclear arms; the less true defense there is, the more potentially effective are the opposing arms.

   The proliferation of nuclear armaments would raise additional grave problems for the assured-destruction doctrine. Retaliatory nuclear strike plans are less likely to be effective against multiple adversaries than against a single adversary, e.g., the coalescence of relatively minor nations into a single nuclear-armed bloc. Even without this type of alliance, the problem of correctly identifying which of several antagonists launched an attack could seriously compromise the doctrine.

8. An important and somewhat hopeful change is the relaxation of the intensity of the feeling of enmity toward our system of government and economic structure by large segments of the population of the USSR and her satellite countries, particularly by the intelligentsia.

   Unfortunately, our study group remains uncertain whether the more sympathetic attitude is shared by the leaders. The tone of official publications, including civil defense publications, remains consistently hostile and is often quite aggressive. The same attitude is present in the satellite countries.

   The magnitude of the effort to increase the armaments of the USSR, both offensive and defensive, is also alarming if considered as an indication of the attitudes of the decision makers.

   For the purposes of the Little Harbor Study, it is well to keep in mind that the installation of effective active and passive defense systems would take years; a change in the attitude of our opponents' leadership may become manifest within hours.

New Weapons and Weapons Effects

The committee has reexamined the 1963 Project Harbor conclusions concerning the likely hazards and kinds of weapons to which the U. S. population could be exposed in the event of a large-scale war. Many new weapons of tactical significance exist, but so far few have shown applicability to massive attacks against a whole population. Nuclear weapons still appear to be the most serious threat to life in such attacks, and the general features of a civil defense system designed to protect against nuclear attack should remain useful in spite of any changes in weaponry in the next 15 years.

This judgment is in agreement with the 1963 conclusions. In addition to restating some of those conclusions, we have added in the following paragraphs a further assessment of the more significant changes anticipated in weaponry and the implications of these changes as far as civil defense is concerned.

The nuclear powers are expected to acquire weapons of even greater efficiency. The bulk of the future missile threat could consist of missiles with warheads of tens of megatons each. Furthermore, new and larger missile systems could be developed and made operational in five or six years, so that, if called for by Soviet planners, a few weapons in the 100-Mt class could become available.

The development of an effective antiballistic missile system has been vigorously pursued in both the United States and the USSR for several years. The current installation of such defense around Moscow is one sign of this development. The response to the deployment of active defense is expected to result in a decrease in size but a multiplication in number of the attacking missiles. Thus, to saturate the defense, an attacker faced with an effective active defense might replace a large-yield weapon with several weapons with much smaller yields. Their total explosive power might be only about one-tenth that of the single large warhead. Because of the greater dispersion, however, the area of potential blast destruction would be reduced much less than the total yield is reduced and would remain comparable with that of the original single warhead.

Another response to an effective defense might be an attack with very large-yield weapons, which could cause fire and blast damage even if the weapons burst outside the range of the defense system, perhaps at very high altitudes. An enemy could also explode his weapons outside the protected region, using surface bursts to create fallout on the cities. Such attacks, however, would not be very effective against a sheltered population.

New attitudes about appropriate targets are likely to develop as the number and efficiency of nuclear weapons available to an attacker grow. With many weapons available, an attacker may be willing to throw large numbers of weapons at a single defended target, or he may contemplate nearly complete destruction of his enemies' offensive forces; with lesser forces he might consider attacking just the population.

Attack with *biological agents* against the U. S. population would be much less effective than a nuclear attack. The delivery of biological agents involves difficult logistics, and their effectiveness is subject to large uncertainties introduced by weather, countermeasures, and the varying susceptibilities of populations. Biological attacks upon food animals, either in conjunction with nuclear attack or alone, may not be as difficult; although feasible, animal protection, e.g., shelters with air filters, is not likely to be available at the time of attack.

Chemical agents are far less effective per pound of weapon than nuclear weapons, and they do not share the infectious nature and thus the persistence of biological agents.

Very *large explosions deep in the ocean* could cause waves hundreds of feet high when breaking along hundreds of miles of shore or continental shelf. The coastal inundation could cause extensive damage and loss of life, but both would be very much less than the loss expected from explosions of similar magnitude in closer proximity to the harbors or cities under attack. Shelters capable of providing protection from direct attack would have to be designed, however, with due consideration of this so-called "Tsunami-wave" threat if they are located in low-lying coastal areas.

Large fires might necessitate temporary isolation of shelters from heat, smoke, and noxious gases in the outside air. Provision for such isolation, "buttoning up," should be contained in the plans for blast shelters since it does not seriously complicate their design. In general, asphyxiation and heat exhaustion of people in shelters are not anticipated to be major dangers.

The *thermal flash* from nuclear detonations is capable of starting fires that can lead to large-scale wild-lands conflagrations but only under the special conditions of weather, season, and topography that would favor the spread of fire. It is unreasonable to fear that most of our woodland would be denuded by fire or radiation because weather conditions favorable for spreading fire rarely occur simultaneously over very large parts of the country. Radiation, both prompt and fallout, can neither cover all areas with doses lethal to all species nor prevent all regrowth of the many species known to revive after burnover or radiation exposure.

Fires from large-yield explosions can occur over large areas (1000 square miles from a 10-Mt burst), but the spread of fire into further areas is generally slow. Aside from occasional short spurts, the average rate of spread is about 500 ft/hr, and the extent of spread is seldom more than 5 to 10 miles in any direction, even in areas of plentiful combustibles. In many suburban areas and in most rural areas, fires will not spread at all, and damage is likely to be limited to isolated fires.

Even in urban mass fires the number of casualties has usually been small. Casualties may rise, however, when blast damage accompanies and aggravates fire problems. In the absence of blast shelters, persons could be trapped in or under collapsed buildings and become fire casualties. Similarly, persons driven from shelters that do not provide fire protection could be exposed to other effects.

The most widespread lethal effect of nuclear explosions remains the radiation from fallout, the effect against which protection is least costly. In addition to the sources of danger that have been considered so far, radiation, heat, and blast, the strong transient electromagnetic pulse accompanying nuclear explosions can cause both temporary disruption and permanent damage to electronic systems and to power grids at fairly large distances from the burst. Shelters should, as much as possible, not depend on external power sources, and consideration should be given to minimizing the damage and injury that may affect communication and power equipment.

At distances from the burst point where the blast pressure is above 15 psi, there is an additional hazard from impacts of crater ejecta lofted by the strong updrafts resulting from multimegaton bursts. Shelters below ground with some earth cover, however, face no high risk from this threat.

Immediate Survival

INTRODUCTION

The term "immediate survival," as used in this report, includes the problem of protecting people and property during nuclear attacks and of ensuring their survival for periods of days to weeks following an attack; some of this time may be in shelters. Warning, protection against immediate effects (radiation, blast, fire), supplying the essentials of life, communication and control, morale, maintenance of law and order, and preparation for recovery operations are also considered under this heading.

The conclusions in the 1963 Project Harbor Summary Report were reexamined in the 1967 Little Harbor Study. Most of them were still valid. The following discussion includes restatements of those that have been significantly changed or on which added information is available, such as those dealing with manpower requirements and with shelter-construction cost estimates. The most important conclusions from the 1963 Summary are repeated with minor changes.

THE PROGRAM

A valid program of protection against the immediate effects of nuclear and other types of weapons must contain short- and long-range goals. The planning should consider local factors, e.g., whether the area is rural or urban or in the vicinity of a possible military target. It should be fully compatible with enlightened peacetime planning and with military planning, and it should include, in particular, plans for active defense. The lead time for most major programs is usually long. Hence, additional consideration should be given to the possibility of crises that may occur before the completion of a reasonable civil defense system.

Federal responsibility for the common defense implies responsibility for the protection of the lives of the civilian population, just as it implies responsibility for deterrence and offensive capability. Under conditions of modern warfare, civil defense cannot be divorced from other forms of defense. At the highest level, all defense policies should be coordinated, as they now are, by the Department of Defense, although the implementation of the policies would and probably should continue to be entrusted to appropriate state and local organizations. However, the development of principles, the coordination of planning, the allocation of funds, and the resolution of problems created by local governments are all responsibilities that the federal government must recognize and assume.

The national civil defense program should be summarized in a handbook designed for the layman, similar to the existing pamphlet, *Fallout Protection,* but containing information on all direct effects of nuclear weapons. The handbook should be made widely available at little or no cost to the public. It should contain information on the long-term effects of nuclear weapons, the recovery from these effects, and the national policy. It should also contain detailed recommendations for procedures in an emergency in terms of improvising or seeking available shelter above or below ground when one cannot take advantage of public civil defense facilities. The handbook should be of high quality, regularly upgraded, advertised, and distributed.

The operation of a civil defense system, e.g., planning, communication and control, shelter management, and maintenance of law and order, during the immediate survival period requires a large and skilled manpower pool. All these demands cannot be met with single-purpose civil defense professionals. Rather, most of the manpower must come from such sources as police and fire departments; it may have to be augmented by the National Guard and other military units. In effect, the dual-use concept must be applied to most of the manpower requirements of civil defense operations. This concept will be further discussed in the chapter on Education and Training.

PRESENT CIVIL DEFENSE ORGANIZATION

At present, the responsibility for planning civil defense and for executing these plans is widely divided. The amendment to the Federal Civil Defense Act makes civil defense a joint federal–state responsibility. As a result, the organizational structure of civil defense is quite complicated and has no well-established lines for communications and decisions.

Most of the planning is done by federal agencies, but much of the execution of these plans is in the hands of state and local officials. Since the federal government cannot order or force the state and city authorities to execute its civil defense plans, the actual level of preparedness shows large variations throughout the country. The control of the federal agencies can be exercised only by imposing conditions for the allocation of civil defense funds. Even when state and local officials wish to cooperate, the complex organizational setup often causes difficulties.

The responsibility for civil defense is widely distributed also within the executive branch of the federal government. The Office of Emergency Planning (OEP) in the Executive Office of the President is responsible for the general coordination of plans and procedures, but it has no operating role. The Office of Civil Defense (OCD) in the Office of the Secretary of the Army is responsible for most operating functions within the federal government. Some of the emergency preparedness functions are, however, assigned to other federal departments and agencies in keeping with their statutory and traditional responsibilities. About 30 departments and agencies have civil defense functions, and the Federal Civil Defense Act discourages the Office of Civil Defense from duplicating functions of other federal agencies. In an emergency, organizations that had only planning functions in peacetime may have to assume operating roles, and this new role may lead to serious difficulties. Manpower at the "doing" level of civil defense comes largely from the state and local organizations that customarily handle emergencies. The police, fire, and health departments are the most prominent, augmented by other community and public-utility employees, and supported by the National Guard and the federal armed forces.

With regard to quantitative requirements for civil defense operation, approximately 5400 full-time civil defense officials plus 2800 man-years/year of part-time and volunteer people man the regional, state, and local civil defense offices. In an emergency this force could be greatly increased by police- and fire-department personnel, thus adding some 800,000 emergency professionals. As a reserve force, the National Guard and the Army Reserve might be called on for another half-million men, already disciplined and organized. The training of these groups is discussed in the chapter on Education and Training.

The most effective way of meeting the requirements of warning, evacuating, sharing of resources, and similar functions would require a unified command; our committee is concerned that such a command is lacking. Closer liaison between the policy-determining organizations and the local organizations and an effective flow of information from the OCD and the military command offices to the local units (and vice versa) appear to us very important.

TYPES OF SHELTERS

The main element of physical preparation for civil defense is the equipped shelter. For convenience of discussion, four general classes of shelters are distinguished and tabulated below:

TYPES OF SHELTERS

Class	Overpressure protection, psi	Protection from fallout radiation*	Protection from initial radiation*	Remarks
I	100	10,000	1000	Provides protection from fire and hot rubble plus emergency escape
II	30–50	200	100	Provides fire protection
III	10	100	10	
IV	None designed specifically	⩾40		Primarily fallout protection only

*Protection is described in terms of a protection factor (PF) which gives the ratio of the radiation intensity in an unprotected location to that in the protected area.

Most present shelters, identified by the National Fallout Shelter Survey, are Class IV shelters. Structures already available have been adapted and marked, and some of them stocked, as fallout shelters.

Upgrading Shelters

Possible approaches to upgrading our present shelter position are:

1. The fallout shelter identification system can be made more effective by surveying residential and nonurban areas to determine capability and capacity for accommodating the population at night as well as during daytime. Such a program is now underway, in part, through the Home Fallout Protection Survey (HFPS).
2. Since a fully developed system may not be available at the time of need, the handbook described earlier should illustrate methods for constructing hasty shelters capable of resisting at least low blast pressures and capable of being constructed by the average citizen in a relatively short time with materials at hand. Such shelters would not provide as much protection as a permanent shelter but would offer considerably better chances for survival than the average home or small structure.
3. There should be a survey of existing shelters to locate those that already are, or can easily be converted to, Class III shelters. The conversion should be carried out if economically feasible. The upgrading of existing shelters to withstand overpressure in excess of 10 psi is limited, in general, to shelters below ground; and even here, generally, upgrading above about 30 psi will be quite costly.
4. Protected storage depots for food, medical supplies, and recovery hardware, including equipment, supplies, and provisions for decontamination, should be established throughout the country. These depots may be associated with currently operating industrial, utility, and hospital facilities and should be capable of serving during an attack and in the postattack environment. The depots should also house vehicles that can be operated during and after an attack to enable maintenance of order outside shelters, to engage in minor fire fighting, to help in evacuating people where required, and to maintain communication.
5. On the basis of system studies and national goals, action should be instituted for incorporation of Class I, II, or

possibly III shelters into new buildings as they are constructed, and incentive payments should be provided as necessary. If this plan is implemented, most new shelters will be useful also in peacetime, i.e., they will be dual-use shelters. The slanting* of such construction to provide 10-psi protection would require only nominal additional cost. However, as protection is increased beyond this pressure, the structural costs will increase significantly, whereas the cost of incorporating the necessary facilities will not increase greatly. If one wants to postpone this additional expense, blast protection, e.g., added shoring, special doors, etc., could be provided when an emergency arises.

6. Information should be provided for individuals, corporations, and groups who wish to undertake private construction of shelters in the absence of, or delay in, federal action on such programs.
7. Information should be provided to permit provision of protection for farm livestock and other commodities to the extent possible. This could be coupled, if necessary, with offering incentives for the implementation of the program recommended.

New Shelters, Single and Dual Purpose

The possibility of improving the protection provided by present shelters should not obscure the fact that even more complete protection could be provided if a program of building new shelters were inaugurated and if new public facilities, such as underground transportation and communication systems, were so designed that they might be converted to shelters in periods of emergency.

The cost of new single-purpose shelters is difficult to estimate until a formal policy of desirable features has been set. Single-purpose shelters can range from low-cost, austere, isolated units having manually operated doors, manually driven ventilation systems, buckets for sanitation, two-week-stay capability, to the more elaborate interconnected systems with automated doors, rest

---

*"Slanting" is a general term denoting incorporation at low cost of certain architectural or engineering features into new structures or, alternatively, making possible quick structural alterations to improve protection of people and supplies from the effects of an attack.

rooms, air conditioning, medical facilities, a month's stay capability, etc. Because of the number of persons to be protected, the cost of shelter systems will represent a large sum. Therefore, an austere system affording the desired protection with a minimum provision for human comfort is the most likely one to be adopted.

The following table gives cost estimates for the relatively austere single-purpose shelters. The estimates are based on present-day technology and include engineering and inspection costs but omit real estate and stocking costs.

COST/SPACE

Size of shelters	100 psi	50 psi	10 psi
100 spaces with 10 sq ft/space	\$600/space	\$500/space	\$400/space
1000 spaces with 10 sq ft/space	\$300/space	\$270/space	\$220/space

These cost estimates are considerably higher than those given in the Harbor Summary (\$300 and \$175, respectively, for the 100-psi case), but they do not necessarily contradict them. The present estimates are based on current technology, which makes the estimates more reliable; the costs given in the Harbor Summary assumed improved techniques and mass-production methods. The cost of a Class I shelter system, which according to the Harbor Summary would assure the survival of 80% of the population in case of a 3000-Mt attack, was based in the Harbor Summary on a cost of \$267 per shelter space.

Dual-purpose construction, which appears quite feasible, would require significantly less federal, state, or local investment than would single-purpose shelters. Dual-purpose-shelter costs are difficult to estimate because of the latitude possible in ascribing the relative share of total cost to the different uses. However, the civil defense increment can be expected to be less than the cost of single-purpose shelters, although the total cost of dual-purpose construction might well be significantly greater than the cost for providing for either of the purposes individually. Further advantages of dual-purpose shelters are the probable reduction in upkeep and maintenance expenses and the more efficient utilization of space.

As an example of the cost of a particular shelter system, the cost of the interconnected-tunnel-grid system, described in Oak Ridge National Laboratory reports, is about $400 per person. This shelter system includes automated doors, rest rooms, air conditioning, a month's stay capability, and 100-psi protection. About $150 per space of the $400 is the cost of construction, the rest, i.e., $250, is for ventilation, refrigeration, sanitation and food-preparation facilities, and similar items. The possibility of tunnel breaching may require blast doors at selected intervals and would increase the cost slightly. Certain utility and service ducts, on the other hand, could be incorporated into such a shelter system in a dual-use service and thus reduce the cost charged to civil defense.

Protection by Blast Shelters

A Class I shelter protects its occupants against the blast from a 1-Mt weapon exploded straight overhead at 5000 ft or higher or from a 10-Mt weapon at 11,000 ft or higher. The corresponding altitude for a 100-Mt weapon is about 20,000 ft. Weapons would have to be exploded at an even lower altitude to cause the maximum number of fatalities. The area in which the Class I shelters would be breached by an explosion at the worst possible height is less than one-tenth of the area in which Class III shelters would be breached by an equally large explosion at a much greater height.

PROTOTYPE SYSTEMS

For acquiring a more complete understanding of the problems connected with the operation of shelters and for ensuring that no significant factor in their design has been overlooked, prototypes of both single- and dual-purpose shelters should be built and staffed. A certain amount of additional research would have to be undertaken before this pilot-plant operation could be most usefully executed. At the same time, a moderate shelter-upgrading program could be undertaken.

In the absence of a prototype system, the results of computer studies of highly idealized shelter programs can be accepted only with reservations at best. Although model shelter studies are required for national planning, detailed system studies necessarily will have to analyze the regional and local situations.

URBAN STRUCTURE AND VULNERABILITY

The trend in the distribution of the population in the United States is toward (1) an increase in the fraction of the people living in metropolitan areas and (2) an expansion of the metropolitan areas to such an extent that the density of people inside these areas decreases in spite of the increase in their total number. The centers of cities for the most part exhibit either population stability or population losses, whereas suburban growth at much lower population densities proceeds. The composition of central-city populations continues to shift toward the socially and economically less-advanced groups. Provisions for guiding and controlling people in shelters in these areas may be more difficult than presently envisioned. This problem deserves study.

Since low population density in the suburbs tends to be reflected in building types, e.g., predominantly frame or masonry instead of massive concrete and steel construction, the average structural hardness of low-density areas is considerably lower than that of metropolitan centers. As a result, the fallout protection identified in existing buildings by past and continuing surveys is heavily concentrated at the centers of the cities where it may exceed the requirements for that area. In terms of civil defense needs, suburban areas require significantly more shelter space with blast and fire protection than now exists. The potential is high for incorporating dual-purpose shelters in schools, public buildings, apartment houses, shopping centers, other commercial and community structures, and as part of underground utility tunnels.

Recovery

INTRODUCTION

The problems of recovering from a nuclear war are more complex and not as well understood as those of protection against the direct effects of an attack. The latter problems are essentially, though not exclusively, physical in nature, whereas the more important problems of recovery are in the realm of economics and the social sciences and include the lasting emotional effects of having gone through a holocaust.

This chapter is divided into three parts dealing with economic, ecological, and medical-radiological problems. Physical problems, such as debris removal and decontamination, are of recognized importance but are not covered by this discussion. Social and emotional problems are not considered in detail either.

This review of postattack-recovery problems is structured somewhat differently from that in the original Harbor Summary. We concur with the main, though perhaps not all, conclusions of the Harbor Summary, however, and in particular are reemphasizing the first conclusion: continuing research is needed to define postattack problems in quantitative terms and to evaluate the relative effectiveness of proposed measures to alleviate postattack situations.

GENERAL REMARKS ON RECOVERY

Civil defense is not restricted to protecting the population from the effects of weapons. It must also ensure that the immediate survivors are not decimated because of failures to provide sustenance, to control disease, and to maintain order. It should also provide the prerequisites of recovery. Although the meaning of recovery cannot be made entirely precise, the dissolution of the United States as a political entity, indefinite continuance of standards of living close to subsistence levels, or the inability of the nation to cope with subsequent external threats would each clearly constitute a failure to recover.

The emphasis on problems of long-term survival and ultimate recovery should depend on the level of the total civil defense program and the range of threats at which that program is directed. At very low levels of expenditure, such as the present federal level of about $0.40 per person per year, the greater vulnerability of unprotected people compared to unprotected productive facilities warrants a high concentration on the survival of people. However, if all the population has good fallout protection and the urban portion has some blast protection, the amount and character of preparedness needed to complement this protection become quite sensitive to the level of attack on urban targets.

ECONOMIC RECOVERY

Up to a certain level of attack, the large preattack value of productive resources per capita provides reasonable assurance that recovery can be achieved if organizational problems and specific localized bottlenecks can be overcome. Accordingly, preparedness measures should focus on organizational arrangements and the identification and elimination of potential bottlenecks. As the hypothetical attack weight successfully delivered on urban targets is increased past the level of about 2000 Mt, extensive preparations become increasingly necessary to permit recovery within a reasonable period. Specific bottlenecks give way to more and more generalized scarcity of resources. If preparations were limited to organizational arrangements, an attack of 2000 Mt successfully delivered against a critical set of industrial targets might severely impair the ability of the economy to support survivors, and the ability of the nation to defend itself against further threats. The damage would be aggravated by any further increase in the weight of the attack; and several critical industries might be virtually eliminated. Preparedness measures required at this threat level therefore involve extensive programs of stockpiling basic machinery and other items. Unless such preparations were made, the economic difficulties following an attack of the indicated magnitude against a well-sheltered population might vitiate the protection afforded by the shelters.

These generalizations relating preparedness measures to attack weights on urban targets are essentially a way of quantifying the obvious fact that the nation's industrial capacity is contained in a finite area and is much more highly concentrated than the population. It is also more difficult to protect than are people. No judgment as to the military feasibility or strategic plausibility of such attacks is implied. Judgments on these matters would obviously have to be on the basis of detailed consideration of the objectives, capabilities, and probable strategies of the two sides. In particular, the presence or absence of active defense, the reliability and retargeting capabilities of the attacker's missiles, and the stage of war at which attacks on cities occur will have a very significant bearing on the attacker's ability and intention to inflict a large and deliberately patterned damage on the economy.

Whatever the plausibility of multithousand-megaton attacks on urban targets, it is clear that for the present and foreseeable future a large range of possible contingencies remains in which much smaller attacks on urban and industrial targets could occur. Continuing programs of economic preparedness at the $0.5 to $1 billion per year level could make a very significant difference in the vulnerability of the economy to these smaller attacks. Such programs would effectively complement shelter construction and other programs if the latter were going forward at an expenditure rate of $2 to $3 billion a year. However, much larger expenditures would be necessary to protect the economy significantly against large attacks.

The present research base for a detailed analysis of economic-preparedness policies is seriously inadequate. Analytical tools now coming into use should produce important improvements. In particular, substantial refinement of the crude estimates already mentioned, indicating the levels of attack at which preparedness requirements rise sharply, should be possible within the next year or two. Identification of industrial sectors on which preparedness should focus will also be improved. Many areas of policy remain, however, where research and the formulation and execution of a program would have to go forward more or less simultaneously. Research is sometimes needed to make policy decisions, but in other cases research is more productive if some policy decisions have already been made.

Two Types of Economic Preparations

There are two types of economic preparations: those aimed at assuring the necessities of life until production of basic commodities can be resumed, and those aimed at facilitating the resumption of such production. The first type essentially buys time for the population to cope with its postattack problems, including the problems of resuming production. Hence, the more extensive the preparations of the first type, the less need for those of the second to achieve a given level of performance.

Preparedness measures in the first category have two great advantages which justify giving them primary emphasis in programs at the $0.5 to $1 billion per year level. First, they are inexpensive compared with measures in the second category. Second, their usefulness is comparatively insensitive to the level and pattern of attack. For example, large food supplies and quick restoration of electric-power distribution will enhance economic performance under almost any attack circumstances.

A spectrum of realistic plans for the restoration of some form of economic organization is needed to carry out preparations of either category. In particular, providing the two most urgent necessities of life, food and shelter, must not depend on the creation of organizations during the sheltering period or thereafter. In areas of heavy bomb damage, the various types of shelters will have to furnish the second necessity well in excess of the period of danger from enemy action. Citywide interconnected shelters would alleviate the problem of communication and render preparations to face a hostile environment outside easier.

The importance of distributing much of our food supply over the United States and of storing it safely and accessibly will be reemphasized later. Some plans for food-distribution centers at least should be made ahead of time. It is necessary also to prepare for the possibility that Washington may be hard hit and federal offices there may cease to function, at least temporarily. Current efforts toward these preparations should be greatly increased. Also, plans should be formulated for dealing with the difficult problems of restoring solvency, clarifying property rights, and reconstituting an exchange economy; these plans must offer reasonable promise of forestalling cumulative economic disorganization. All the plans should be tested by simulation exercises involving people who might actually perform these activities in the aftermath of an attack.

To date, planning for economic organization in the aftermath of nuclear attack has been based on the creation, as soon as possible after the attack, of an apparatus for government control of the economy rather more extensive than that which existed in World War II. It seems unlikely that such an apparatus could be created after attack in time to affect the course of events significantly when the survival of much of the population is at stake. The arrangements that would prevail during the crucial period remain very vague indeed.

Buying Time: Stockpiling

Even if surviving resources are generally abundant, some time to achieve viability will be needed, i.e., time to reorganize, to relocate population and resources, and to solve a large number of particular problems of production. Rather than attempt to identify and solve all such problems in advance, preparedness policy should attempt to provide the survivors with enough time to solve the problems themselves. Time is bought by increasing the surviving inventory of consumer goods, of which food is much the most important component. Large, well-distributed, and protected food supplies would enhance recovery under all circumstances. They would make the resumption of agricultural production and the transportation of its products less urgent. By assuring the availability of the next day's bread, they would create more favorable conditions enabling people to devote their energies to rebuilding the economy.

In recent years, success in reducing surplus stocks of grains has substantially reduced the magnitude of the nation's most important reserve. As of July 1, 1967, roughly the time of the seasonal minimum, the national food supply represented about 19 months' requirement for the entire population. (It has greatly increased since then as a result of the good crop of last year.) The composition of the food supply, even assuming that it is properly located, which is not the case now, left a good deal to be desired. More than half the total was represented by feed-corn stocks.

A one and one-half year supply of food for the entire population at the seasonal minimum is probably an acceptable level. That supply, however, should be of reasonable composition. Not only should it meet reasonable physiological standards, it should also reflect existing consumption patterns. Such was not the situation in July 1967. Thus, in the case of feed corn, even allowing a tenfold increase over present per capita consumption of corn meal and other corn products, the corn would have outlasted all other food stocks.

Buying Time: Dealing with Disruption and Local Scarcities

Transportation, communication, and utilities share a number of important characteristics. They are clearly crucial to an effective utilization of production facilities of all types, to achieving effective economic organization, and to providing time to solve problems. The assessment of the total economic implications of a substantial attack on any one of these industries is simply beyond the state of the art in economic analysis and is likely to remain so for some time to come. Individual items of the networks involved are specifically located; e.g., a surviving bridge across the Ohio cannot readily perform the functions of a destroyed one across the Mississippi. An analysis which adequately reflects this fact must also reflect similar facts in all related economic activities. With the transportation system intact, the total capacity of the surviving steel plants matters a great deal more than their location. But, if transportation is badly damaged, both the locations of the surviving transportation links and the locations of the surviving steel plants become highly relevant.

Few of our industrial plants produce their own power; most of them rely on power furnished by utilities. Hence, the importance of restoring utility plants and their transmission lines. Preparedness programs should include, first, special shelter programs for workers and their families in transportation, communication, and utilities industries located close to the place of work; and, second, stockpiles of supplies, tools, and components needed for repair and patchup, the amounts determined by careful analysis of system vulnerabilities to a foreseeable range of attacks. In addition, consideration might be given to the creation of hardened regional emergency organizations prepared to handle a variety of crucial repair and patchup tasks.

The problem of utilities is partly alleviated, partly aggravated by the recent trend toward nuclear power: nuclear power plants are less dependent on fuel transportation than conventional power plants and are smaller. Hence they could more easily be protected. They could be operated for extended periods even if the transportation system were significantly impaired. On the other hand, unless they are protected, their destruction may result in the spreading of large amounts of radioactivity. The protection provided at present could be strengthened, for instance, by locating the plants underground in structures similar to those used in Sweden.

Transportation, and to a lesser extent electric-power generation, is dependent on supplies of gasoline and distillate. Stocks of these items are normally quite low, not more than a two- or three-month supply. Essential postattack demands would be a small fraction of current consumption rates, but a substantial fraction of stocks would be destroyed if petroleum refineries were hard hit in the attack. Thus, some stockpiling of refined petroleum products in dispersed locations is probably a high priority measure even at fairly low budget levels for economic preparedness.

Preventing Capacity Shortages in Critical Industries

Programs for dealing with over-all shortages can be considered only at high budget levels and on the basis of extensive analysis.

The identification of the most critical industrial sectors should be based on an examination of the path the economy might take to achieve viability after attacks which an adversary might be able to mount. What determines criticality is not just the level of damage or even the relation between surviving capacity and requirements, but rather the relation between supply and essential requirements after all feasible adjustments on both sides of that balance have been allowed for. Given a determination of critical sectors, the difficult and complex question remains of what measures, such as stockpiling end products, subsidizing underground construction by private firms, and stockpiling machinery or critical components, would afford the most preparedness at a given cost.

On the basis of existing knowledge, the following industries seem to be likely candidates for major preparedness programs: (a) Petroleum refining. Petroleum products are needed in transportation, agriculture, and power generation. In addition, the industry is sufficiently concentrated to be a logical candidate for selection by the enemy as a target. (b) Chemical industry. Chemical plants, especially those producing insecticides, pesticides, drugs, and tetraethyl lead, are potential targets. Tetraethyl lead is included because, in the event the refineries are destroyed, it could be used to enhance the octane of natural gasoline, which then could be used in place of refined gasoline. The other chemical industries are included on the grounds that essential postattack demands could easily be as high as preattack demands, but supply may be greatly curtailed. A similar supply to demand ratio may apply also to various other components of medical and public-health services.

ECOLOGICAL RECOVERY

Although uncertainty exists about the severity and precise character of the long-term impact of a nuclear attack on our environment, particularly at levels of attack exceeding 10,000 Mt, no known effects would preclude ecological recovery. Man and many species of plants and animals have repeatedly demonstrated the persistence of species under highly adverse circumstances. The most devastating nuclear attack that the study considered, ground burst totaling about 12,000 Mt would leave areas of landscape surviving amidst destruction; smaller attacks would leave areas of destroyed landscape surrounded by less-damaged land. Many serious short-term environmental problems would result. Their severity is related to the timing and magnitude of the attack. Available knowledge indicates that advanced planning can be effective in enabling man, if protected by a shelter program, to emerge from his shelter to survive in a damaged environment and to cope with environmental problems.

Radiation Effects on Plants

Radiation from fallout can kill or otherwise affect many plants. Crop plants are damaged by exposures varying from 2000 to 35,000 r of gamma radiation, and this radiation may seriously affect the agricultural production in the year of the attack. However, the next crop should be essentially normal if viable seeds are available. None of the smaller, more plausible attacks could produce long-term protracted exposures from residual long-lived contamination sufficient to cause major damage to large areas of the United States.

Radiation exposure of 1000 r would destroy coniferous forests, an exposure of 10,000 to 20,000 r would destroy a deciduous forest, and 20,000 to 40,000 r would kill a grassland. According to present information, even an attack of 12,000 Mt, ground burst, would not damage more than 10% of our forest land so severely that the recovery would take a period of the order of decades. Field studies in experimentally irradiated tropical rain forests, in several eastern hardwood and mixed hardwood and conifer forests, and also in the Pacific Islands damaged by weapons testing, have all indicated rapid recolonization by vegetation.

A reasonable conclusion, therefore, is that long-term ecological effects would not be severe enough to prohibit or seriously delay recovery. Areas of uncertainty that could be critical do exist, however.

One such area of uncertainty is the effect of beta rays from fallout particles. Present information is far from adequate. The committee advocates increased research effort in this area. Knowledge of the effect of beta particles upon food and forage crops is particularly meager. Beta rays seem to create a greater hazard than was originally supposed.

Radiation Effects on Animals

Domestic animals are killed by acute exposures of 500 to 1000 r. This is the $LD_{50/30}$, the exposure that has lethal consequences within 30 days for 50% of those subjected to it. Animals that receive sublethal exposures from external radiation and ingested radioactive elements would remain suitable as food, and many of them suitable for breeding.

Totally destructive insect plagues are not to be expected. Exposures 10 to 100 times greater than those necessary to kill birds are required to produce lethality in adult insects. However, insects in their larval stages are more radiosensitive than adults, and exposures high enough to kill birds would likely be lethal to many segments of insect populations. Insects are controlled by predatory insects, birds, insecticides, the availability of specific plants for food, weather conditions, etc. The interactions of these factors imply that radiosensitivity alone cannot be used to predict major fluctuations of insect populations. Field radiation experiments to date have shown no clear tendency toward a large increase of the insect population. Historically, the pine and spruce forests or the single-crop agricultural areas have been most vulnerable to insect attacks. Control of crop pests during postattack recovery may be primarily an economic problem involving the cost of insecticides, as it is now.

Fire

The spread of fires, as it affects people and shelters, was mentioned in the preceding chapter. The vulnerability of forests and agricultural land depends on their geographical, climatic, and floristic features. Whether or not large fires would result from a nuclear attack would depend on these features as well as on the mode and magnitude of the attack. Although some areas would be vulnerable, few large-scale forest fires would be likely. The increased flammability of vegetation killed by radiation, however, increases the fire threat in areas of heavy fallout.

Ecologically, fire is not always damaging in the long run. In fact, frequent fires are necessary to maintain certain grazing lands and pine forests. These aspects of fire must be considered in assessing total ecological effects.

Fallout and Residual Contamination

The problem of food contamination is restricted largely to contamination from two relatively short-lived fallout radionuclides, iodine-131 and strontium-89 (half-lives 8 and 50 days, respectively) and two longer-lived radionuclides, strontium-90 and cesium-137 (both half-lives 27 years). Although eating contaminated food is obviously preferable to starvation, both contingencies can be avoided if sufficient food is stored so that it is protected from fallout. Uncertainty still exists regarding the long-term effects of these radionuclides on plants, animals, and man. Continued research on this subject, as well as on the general subject of the transfer of radioactive nuclides from soil and water to plants, from plants to animals, and from animals, if they are eaten, to man, is highly desirable.

Countermeasures

Protective countermeasures against the immediate effects of nuclear war are more important at present than those against long-term effects. Current technology makes it possible to enumerate countermeasures that could be used to aid short-term agricultural recovery as well as the recovery of wild lands. However, the methods and cost of such measures cannot be estimated until we have a better understanding of second-order effects, such as the movement of soluble radionuclides in nature, erosion of land denuded by radiation or fire, and the time needed for natural repair and recovery mechanisms to become effective.

To minimize short-term problems and enhance recovery, the committee recommends that:

1. Existing or future civil defense organizations formulate plans and train personnel in environmental defense.
2. Seed, insecticides, and basic agricultural equipment be stockpiled.
3. Existing agencies responsible for erosion control, watershed protection, and reforestation familiarize themselves with postattack problems and possible countermeasures.
4. Food stocks not be allowed to drop below an 18-month supply, and local and state planning authorities become familiar with the locations of the stockpiles.
5. A study be undertaken on the possibility of using jobless migrants for conservation operations and preparedness measures in areas where postattack problems are foreseen.
6. Current research on the behavior of fallout particles and beta radiation in land and water systems be continued to arrive at better estimates of radiation effects and contamination. A real-time monitor–warning system for fallout should be studied for feasibility.

MEDICAL RECOVERY

It is important that the medical program for the postattack period be carried out with close attention to the changing military and civil defense needs. We wish to reemphasize the importance of continued attention to the following tasks:

1. Plans and continued research on interacting secondary disaster medicine, human rehabilitation, and animal diseases likely to result from the disrupted economy.
2. Development of a variety of plans for the medical care of economically distressed and displaced persons.
3. Estimation of the consequences and the possible means of alleviation of changes in food patterns and in the availability of essential varieties of food. In particular, attention should be directed toward the deficiency diseases which may develop during protracted periods of deprivation. The problem of feeding babies during the critical immediate-postattack period when hazardous amounts of radioiodine may be present in milk should receive added thought and attention.
4. Support for and encouragement of vaccination and immunization programs for the diseases of man and food-producing animals, which may become a hazard either by reason of biological warfare or because of loss of ordinary public-health control. Where booster vaccines are known to be useful, they should be suitably stockpiled. The spread of many diseases can be prevented. Control or preventive measures other than vaccination and immunization should also be explored and considered whenever health plans are formulated. Diagnosticians and pathologists often show a lack of awareness in the recognition of diseases which are rare in our present circumstances but could spread widely as a result of population dislocations caused by a nuclear attack. An educational program to make them aware of and able to recognize the diseases in question might well be instituted for physicians and veterinarians.
5. A study of the economics and logistics of vaccine, antisera, etc.; producers; pharmaceutical manufacturers; and the fabricators of medical equipment and instruments should be undertaken to identify bottlenecks that may develop during a disaster. Such bottlenecks may well be caused by the particular location of the industry or the short supply of key items or because a foreign source has been closed.

Alternate sources of supply or other means for speedy restoration of production should be developed.

6. The program of the Department of Health, Education, and Welfare to institute emergency hospitals and to equip existing ones for emergency service should be further encouraged. Preparations should be made for the repair, restoration, and decontamination of deactivated hospitals. Medical and paramedical institutions and schools must be reactivated to ensure an orderly replacement of medical personnel and technicians. It should be kept in mind that most medical and paramedical institutions and schools are located in the inner city and that their loss could place a serious burden upon the recovery process.

Education and Training

The education and training program in civil defense has five objectives: (1) professional education of full-time civil defense executive and staff personnel; (2) informing and orienting the general public; (3) providing operating experience to local government officials; (4) training personnel who have emergency and recovery duties related to their regular jobs; and (5) making people in technical professions aware of the objectives and problems of civil defense. Many of these programs are active now and are discussed here for support and emphasis. We propose modification and expansion of some.

1. *Professional Education of Full-Time Civil Defense Executive and Staff Personnel*

   Thorough professional competence of full-time civil defense officials is vital to the success of all facets of civil defense planning and operations. It is also essential for the acceptance of civil defense programs by state and local officials and related federal officials whose responsibilities affect, and should be affected by, civil defense. Adequate coverage of this need can be provided by: (a) a preparatory orientation and training program for professional recruits; (b) a command and staff school to prepare personnel for advancement and executive responsibility; (c) a planning staff associated with the command and staff school to contribute to developing a coherent doctrine and the operating policies and procedures for civil defense. The recommended command-staff school is essentially identical to the Civil Defense Institute recommended in the original Harbor Report.

In its training activity, the command-staff school should provide instruction to those who can be expected, by inclination and previous training, to devote at least a major part of their careers to the tasks of the civil defense organization and to assume important functions therein. The planning staff could do most of the instruction, thereby remaining in close contact with new civil defense officers and personnel. An intimate contact between the staff of the school and the Director of the Office of Civil Defense is most desirable. Possibly, the OCD Staff College in Battle Creek could, after considerable expansion of its facilities and personnel, fulfill this function.

2. *Informing and Orienting the General Public*

Should civil defense emergency and recovery measures ever be required by an actual nuclear attack or should an advanced state of readiness including civil defense measures ever be ordered during an international crisis, these measures will be effective in greater or lesser degree depending on how well the general public, especially the urban public, is informed about them. To reach the state of having an adequately informed public will require a long-term and continuous effort. The principal means of informing the public are: (a) job or common-interest group orientation through employers, unions, parent–teacher associations, and similar organizations; (b) adult education, including general orientation and practical instruction; (c) public education in secondary school and college curricula; and (d) general information disseminated by the mass media.

3. *Providing Operating Experience to Local Government Officials*

Civil defense emergency operations and recovery activities usually will be largely in the hands of local officials. These officials, particularly those who man local control centers, should have training to enable them to form an operating organization. Since actual situations cannot be experienced in the course of the training, realistic simulation, as used in command-post exercises or army field maneuvers, should be provided. The following steps may be necessary: (a) acquaint personnel who may be called upon in a real emergency with the methods of simulation training—this is the training procedure in which they react to messages similar to those they would receive in an actual attack, and their reactions are discussed and analyzed afterward; (b) prepare packages containing simulated messages of the kind described which are adapted to local conditions; (c) devise a program for the gradual expansion of simulation training from locally centered through regionally oriented to nationally integrated exercises, including coordination of civil defense exercises with the NORAD "Desk Top" exercises.

4. *Training Personnel Who Have Emergency and Recovery Duties Related to Their Regular Jobs*

During an emergency most of the working-level personnel of the civil defense effort will come from state and local organizations, such as police and fire departments, whose full-time duties in peace time include reacting to civil emergencies. These agencies will be supplemented by their own auxiliaries and other local volunteer organizations. The next source of supplementation is the National Guard; and the final recourse, as far as people can be identified by organizational affiliation before the emergency, is the federal forces, such as military units, that are located nearby. All personnel from these sources have training relevant to emergency operations, and they are organized to apply this training. To render them effective for coping with the problems that may arise from a nuclear attack, they should be given supplementary training in specific civil defense functions, such as radiation monitoring and reporting, and use of shelter facilities, of stocks in shelters, and the like. Not only such local organizations as police and fire departments, but the National Guard and the Army Reserve units also should undergo training in these subjects. We have recommended that the Continental Army Command, which has responsibility for training Army personnel for civil defense functions, make civil defense training part of the basic training of all armed forces.

Some of the personnel in each of the above categories should be qualified as instructors so they may continue to give courses in their own organization and to instruct shelter occupants in basic nuclear hygiene, recovery procedures, etc.

A Department of Defense directive (No. 3025.10, dated Apr. 23, 1963) established general guidelines for military support of civil defense and assigned the major responsibility to the Continental Army Command. During the five years since the directive was issued, much progress has been made, and at present the Adjutants General of every state have been assigned small planning staffs to assist them in the development of a state plan for the use of military personnel to support local civilian authorities during a civil defense emergency. This program has the potential for ultimately providing a real operational capability for civil defense throughout the country, and it should therefore be encouraged and strengthened.

The preceding proposals constitute, perhaps, the most significant departure from the recommendations of the original Harbor Report. They advocate training existing personnel of certain state and local organizations for civil defense functions and relying on these persons to a very large extent in case of emergencies, rather than depending on a large, full-time (single-purpose) civil defense force.

5. *Making People in Technical Professions Aware of the Objectives and Problems of Civil Defense*

A number of technical professions are particularly relevant to either civil defense operations (e.g., medicine) or civil defense preparations (e.g., architecture and engineering). The short courses and training programs that have been organized by the OCD Staff College can provide special knowledge concerning thermonuclear war and the problems of civil defense in coping with the direct effects of nuclear weapons and the procedures of recovery. With this type of knowledge, technical professionals can use their expertise to help solve civil defense problems.

Acceptance of Civil Defense Programs*

If a civil defense program were developed without regard for its image and its impact, the resulting program would lack the motivations, beliefs, attitudes, incentives, and expectations that are needed to support it; it would not serve the goals, aspirations, and values which it is supposed to further. These larger considerations are outside the scope for explicit consideration in most civil defense studies and plans, but they are of decisive importance in judging the realizability and desirability of a civil defense program.

In an attempt to assess the probability of acceptance of civil defense programs, both what is to be accepted and what is meant by acceptance must be specified.

The minimal characteristics of what is to be accepted are (1) the existence of a threat whose severity, probability, and timing deserve the defensive efforts proposed and (2) a program, as well as a goal, which is sensitive to changing conditions and which will reduce the threat or ameliorate its consequences at a cost and with a level of effectiveness and consequent benefits that merit the program's implementation. The civil defense program should be closely adapted to the changing character of the threat since the interaction between the two is part of the situation to be accepted. Just as with other strategic programs, the civil defense program should not, either actually or in appearance, significantly

---

*No need was found to update or otherwise modify the conclusions of the Project Harbor Summary on the subject of impact, i.e., impact outside the context of national strategic posture.

increase (a) the incentive for another nation to attack, (b) another nation's fear of being attacked, or (c) the development of countermeasures that escalate the cost of defense without significantly altering the balance of deterrence or level of security.*

Acceptance is not so much a simple attitudinal matter, i.e., attitudes of liking, interest, or even confidence, but rather: (1) a belief in the existence of certain conditions of threat; (2) an understanding of the consequences of possible responses; and (3) an assignment of sufficient priority to those actions that implement the program for ameliorating the threat.

Widespread belief in, and understanding of, situations in which many characteristics are changing and changing each other is difficult to secure. If belief and understanding are achieved among opinion leaders, however, more general belief and understanding are hastened. Furthermore, a shift in assigned priority of action is required initially only of decision makers,† i.e., those who initiate, plan, decide, budget, and the like. They are a very small segment of the population, but the larger public, given the supporting belief in conditions and faith that the decision makers have understood the consequences of responses, will correspondingly shift its priorities. The likelihood and extent of acceptance are increased therefore if a decision maker (1) increases the credibility of the assessment of the threat; (2) clarifies thoroughly the implications of the possible responses; (3) restricts the pace of required change in currently accepted priorities; (4) restricts the number of people whose direct participation is required; and (5) minimizes the resource commitments made necessary.

A program to fit such a set of conditions is not easy, and it will be relatively slow; but it should have a better image than a coerced rapid preparation for facing an attack. Given enough time, it should also be more effective.

Experience of the Office of Civil Defense in the interval since Project Harbor indicates that the problem of acceptance of civil defense by the public is not as serious as it was once thought to be.‡ Mail returns from householders in several states on a

---

*These considerations play a major role in the chapter on Threat.

†Note that decision makers are often among the opinion leaders, but there are many more opinion leaders than decision makers.

‡The research of Professor Jiri Nehnevajsa at the University of Pittsburgh also substantiated this point.

questionnaire asking for information on their homes with a view to evaluating and adapting their basements as shelters ranged from 73 to 85%. Such a remarkably high response is hardly indicative of apathy. Experience with shelter licensing shows that among building owners and managers only 3% refuse to make their property available because they are opposed to civil defense, indicating a high degree of acceptance of at least this facet of civil defense. The problem of acceptance appears to lie more with opinion leaders than with the general public and with various aspects of the program rather than its overall value. Opinion leaders are mostly sensitive and thoughtful people, and many hard questions must be considered regarding civil defense. Many interdependent and conditional factors affect civil defense and its effects. Even the physical nature of the threat is uncertain: if one prepares for fallout, the threat shifts to blast; if for blast of a given magnitude, then the magnitude increases. If one prepares to evacuate and stockpiles for industrial recovery, the enemy may be impelled to strike first. If a program is hurried, how is it interpreted? What gave it such priority? If it is slow, is it sufficiently effective? If it is big, is it worth the cost?

In a system of conditions so evasive of control, simplification is a necessity, though fraught with the danger that simplification may turn out to be oversimplification. Most people will fix on one or another point or principle to eliminate some of the interactive complexity from detailed consideration. Each of these simplified points is then regarded as a fixed assumption or basic tenet by some people; for others the points will still be open to debate and examination. Examples of such points are (1) there is certain to be a nuclear attack some day, some place; (2) if we are peaceful, we never will be attacked; (3) becoming as strong as possible is a national duty; (4) a strong United States is as great a menace to peace as any other strong country can be; and (5) saving lives is worthwhile even if postattack conditions are unclear or unmanageable; (6) civil defense cannot help but make war more likely; (7) postattack conditions will be manageable; (8) protection must completely eliminate differences in risk among people; and (9) certain values are eternal and must be defended against any attack no matter how severe it is.

Acceptance is, of course, impeded by adherence to some of these points and enhanced by adherence to others. If a civil defense program is a defensible component of our national strategic posture, critical dialogue will gradually expose oversimplifications and will lead to acceptance of civil defense on a sound basis of understanding.

In the light of past and proposed programs of civil defense, one can list the following factors that inhibit acceptance of civil defense:

1. The seriousness and unattractiveness of the conditions that have to be considered.
2. Past confusions, disputes, and low evaluations regarding certain civil defense programs.
3. Unrealistic images and inflated figures on the value of certain civil defense programs.
4. Optimism about, and interest in, other more dramatic programs.
5. Contesting rival priorities for political attention.
6. The dullness of many of the behaviors required in passive, unused, standby civil defense programs.
7. The lack of immediate utility of the types of behavior required by civil defense programs.
8. The extremely dynamic nature of the continuing dialogue on national defense and international relations.
9. The low level of official attention to the assessment of the impact of civil defense on the balance of deterrence and the cost of national defense.
10. Apprehensions about side effects, i.e., peacetime effects of civil defense on the nature of American society.

The following factors contribute to the acceptance of civil defense programs:

1. A program tied to a total, long-term threat and not merely to a particular crisis or a single opponent nation.
2. A program that emphasizes a character for civil defense that is nonthreatening to other nations.
3. A program based on assumptions that are both sound and plausible even though not attractive.
4. A graded, slowly evolving program of increasing utility and protection that can be sensitive to local and international conditions.
5. Federal collaboration with state and local governments to assimilate civil defense into continuing state and local government operations.

6. Professionalization and specialization of civil defense tasks and services.
7. A program that sets some of its priorities by planning for a combination of usages that contribute to other desirable objectives and programs, both governmental and private.
8. Dual use of personnel, as well as facilities, instead of a specialized, unused, standby cadre.
9. Measures combatting the threat of a military attack and natural disasters and also responding to social needs under noncrisis conditions.

The Threat*

INTRODUCTION

This chapter is a reexamination of the conclusions of the Harbor Project concerning the circumstances under which nuclear war may occur. In addition, it comments on some studies that have been conducted to determine the relative effectiveness of countermeasures against various levels of attack,† and it attempts to assess the relation of civil defense to other damage-limiting systems.

EVALUATION OF THREATS

We concur in the conclusion of the original Harbor Report that any general war is likely to be preceded by a buildup of tensions, possibly even limited military action, which would provide days to

*Dr. Winter believes that a very substantial expansion of civil defense and other preparedness programs is consistent with a national strategy that primarily emphasizes the deterrence of nuclear war and that such an expansion would be undesirable if it were not so consistent. He further holds that the rational case for preparedness is, in the words of the chapter on Acceptance, "tied to a total, long-term threat and not merely to a particular crisis or a single opponent nation" and that it should emphasize the wide range of contingencies in which the United States might suffer attacks by forces smaller than the full strategic arsenal of a strong nuclear power. Much of the Threat chapter, and points five and six of the chapter on Changes in Strategic Outlook, appear to him to be incompatible with these views, and he would accordingly like to note his nonconcurrence in those portions of the report.

†The Little Harbor Study, when concerned with levels of hypothetical attacks, used 2000 to 4000-Mt-attack studies, except for ecological consequences where attacks up to 12,000 Mt were considered.

months of strategic warning. Nevertheless, massive surprize attacks cannot be ruled out completely.

Although our committee views the USSR as the primary threat, China is a potentially hostile nation that shows growing nuclear capabilities; there may be others in the future. We are also concerned about nuclear blackmail because it may become a threat to our freedoms and principles whether or not it ultimately leads to war. The question of how a civil defense capability affects it should be examined further.

When assessing future threats one must take into account (1) the likely advance in weapon technology and probable improvements in missile systems, (2) the opportunity for protection through shelter and active defense, and (3) the possible impact or reaction that such defense, both active and passive, is likely to have on enemy objectives and tactics.

The effectiveness of future weapons and the capabilities of shelters to withstand various weapon effects are reasonably well understood and have been discussed in the preceding chapters. However, the complementary or competitive role of shelter and ABM systems is not adequately understood. Nor have probable enemy responses to shelters and ABM's been well explored. The committee considers further examination of these questions to be an urgent and important national task.

COST-EFFECTIVENESS STUDIES

Opposition to civil defense programs has often been motivated by the presumed reaction of potential enemy nations to such programs. The following is a typical assertion of the futility of civil defense measures against the initial effects of nuclear weapons:

> Within the framework of the concept of deterrence, civil defense simply does not make sense. It is not an efficient way of spending the deterrent dollar. In the calculus of weapons systems and their effect upon an enemy's intentions, we can obtain more of an impact by spending our money for retaliatory weapons of our own. Dollar for dollar, the aggressor who is intent upon the massive annihilation of people can almost surely keep ahead of the pick-and-shovel work of moving underground for passive defense.

What does it cost to shelter people, and what does it cost the attacker to kill people, sheltered and unsheltered?

In the Immediate Survival chapter, estimates of the average cost per person for blast shelter in an austere single-purpose system (a 1000-space shelter at 10 sq ft/space, built on publicly owned property) were:

	Blast level, psi		
	15	50	100
Cost/space	$240	$270	$300

The cost per person to the attacker depends on (1) the cost of a delivered weapon, (2) the hardness of shelters, and (3) the density of the sheltered population. The cost and 10 years' maintenance of a 1-Mt nuclear warhead and its rocket delivery system is about $9 million, that of a 10-Mt warhead is about $50 million. If we consider an air burst to maximize blast overpressure, the areas covered by various levels of destruction are:

	Blast level, psi		
	15	50	100
Area covered* by 1-Mt explosion, square miles	10	2	1
Area covered by 10-Mt explosion, square miles	46	9	4

A typical population density in cities is 10,000 people per square mile, e.g., the density in the District of Columbia is slightly more than 12,000 people per square mile. If the density of population is 10,000 per square mile and the cost is $9 million for a 1-Mt weapon delivered, the cost of causing a fatality or a very serious injury at the various levels of blast resistance becomes:

	Blast level, psi		
	15	50	100
Cost/person	$90	$450	$900

*This assumes air bursts to maximize coverage but nonideal surface (city) conditions, which reduce blast somewhat from that on ideal surfaces.

These costs are directly proportional to weapon costs and inversely proportional to population density. Hence, only where the population density exceeds 30,000 persons per square mile does the cost of destruction drop below the cost of the 100-psi shelter ($300/person). The comparison is even more favorable if the enemy uses 10-Mt weapons costing $50 million each.

In 1975 the number of U. S. citizens expected to be living at densities exceeding 30,000 per square mile can be read off Fig. 1.*

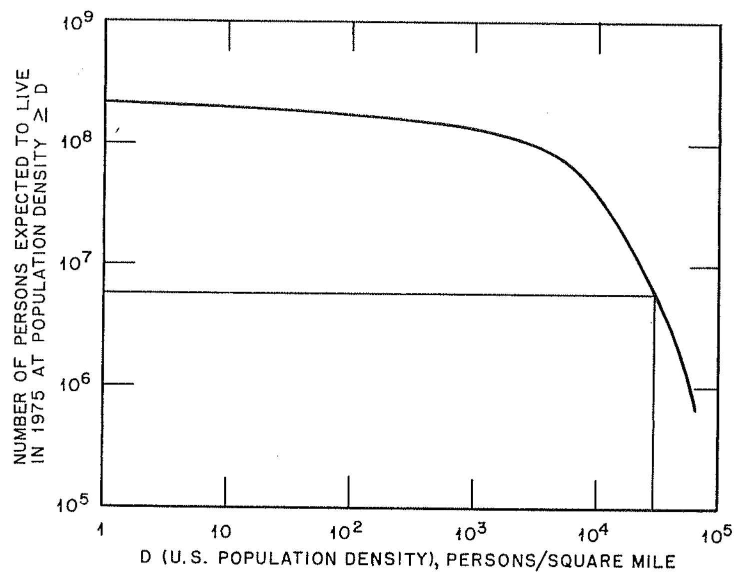

FIGURE 1.

It is 6 million, and they are expected to live on a land area totaling only about 150 square miles. To attack them effectively in 100-psi shelters would cost the attacker more than 150 1-Mt weapons, or about $1.4 billion. To shelter them would cost us $1.8 billion. In other words, if a determined enemy were to choose to attack this denser part of the population (less than 3%), the cost to him would still be comparable to the cost of shelter.

---

*We are indebted to the Stanford Research Institute for the data of Figs. 1 and 2. See also the report of their Missile Defense Analysis Project: 1960 Population of the U. S. by 5-km Quadrangles, Rev. Ed., August 1965.

INTERPRETATION OF COST CALCULATIONS

The preceding cost comparisons are incomplete in at least two respects. First, they consider fatalities as the sole measure of damage caused by enemy weapons and disregard damage to residences and industrial installations. Second, they assume that the enemy attack would be directed against those who are protected by blast shelters. It does not seem reasonable to assume that 100-psi blast shelters will be built for all people of the United States (over 200 million). That endeavor would cost about $60 billion. If not all the population is sheltered, the attacker may direct some or even most of his weapons against those who are not protected to cause the greatest number of casualties. Consequently, the ratio of the cost of shelters to the cost of their destruction for a specified density of population is not as meaningful as the number of casualties that can be inflicted on the country as a whole against a defense costing a certain amount, by an offensive capability involving (a) the same expenditure and (b) the same expenditure in addition to that already made.

When making these calculations, the committee disregarded a number of factors which would alter the number of casualties that are to be feared. Factors that would lower estimates of casualties are (1) evacuations to decrease the number of people in areas of high population density, (2) the fact that the enemy can hardly be expected to use all its weapons for antipopulation attacks, and (3) the most important, that the ballistic missile and air defense would reduce the weight of the attack. As mentioned before, ABM systems can be counted upon to cause modifications of the enemy's weapons, which will result in a reduced effective explosive power. On the other hand, we assumed that all the people, including the rural sections, would be protected against fallout, i.e., that something similar to the full fallout-shelter program had been put into effect. We assumed, also, that there would be sufficient warning time for the population to take advantage of the shelters. Although in most circumstances more than enough time would be available, sufficient warning time would be more difficult to provide for the worst, but unlikely, case of a massive sudden attack not preceded by some developing crisis. For making optimal use of the shelters in case of a sudden attack, they would have to be so arranged and the warning system so designed that people could reach shelter before an attack with intercontinental missiles arrives. Such an arrangement of shelters and a corresponding warning system appear to be feasible. However, even the installation of the fastest warning system and the most suitable shelter arrangements considered so far would not be effective against a missile attack launched from submarines. The flight time of missiles from submarines lies in the range of 5 to 10 minutes. Of course, much of our military intelligence effort is aimed at anticipating just such surprise attacks.

We have calculated the approximate number of fatalities that can be inflicted on the country as a whole by an attack with 10-Mt missiles costing as much as the shelter system to be postulated. As will be seen from the tabulation, the range of nuclear weapons for creating casualties in the absence of blast shelters plays an important role. Since we assumed that fallout shelters are available to everyone, the range can be expressed in terms of blast pressure. The calculations were carried out under the assumption that the mid-lethal range is that where the blast pressure has dropped to 15 psi. Even this limit is valid only if some protection, such as hasty shelters, can be assumed in addition to the fallout protection. Two alternatives were considered: (1) that every weapon finds its target and (2) that only two-thirds of them do. The latter is the customary assumption and takes care of duds and various kinds of malfunctioning of the propulsion and guidance systems. It does not account for the effect of ABM.

The calculations that follow are based on the population distribution expected for 1975 and represented in Fig. 2. The squares referred to in the abscissa have sides 5 km long and hence an area close to 10 square miles. The squares are arranged in order of decreasing population density so that, for instance, the first 100 squares contain as much population (about 22 million people) as any 100 squares, 5 km by 5 km each, contain. The ordinate represents the aggregate population. Thus, as implied above, the 100 most densely populated 5 km by 5 km squares will contain, according to the figure, a total of 22 million people in 1975. The calculations also assume that the enemy uses 10-Mt weapons costing \$50 million each. This may be a higher cost than would correspond to \$9 million for 1-Mt weapons. It was assumed, further, that all people living in areas with a population density in excess of 5000 per square mile would be provided with blast shelters, i.e., 76 million people, at a cost of \$22.8 billion. If the enemy spends the same amount on weapons, he would have 456

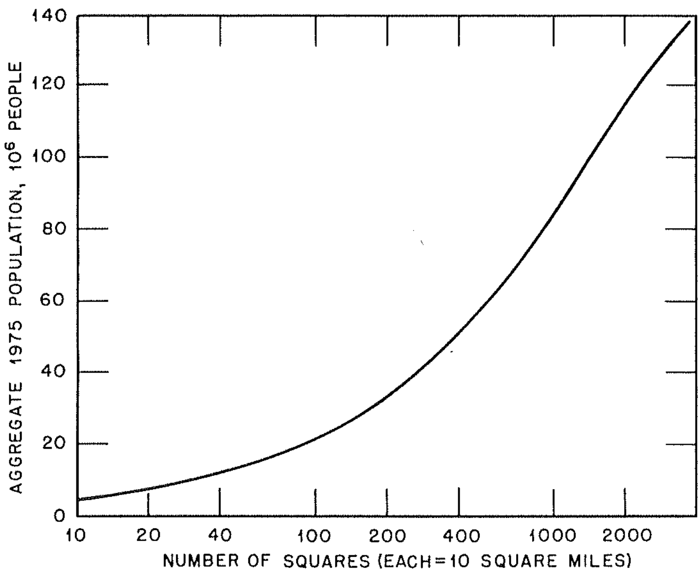

FIGURE 2.

of the 10-Mt weapons. His targeting was assumed to aim at causing the maximum number of fatalities. This will be the case if he uses air bursts rather than surface bursts, which, on the other hand, would minimize the total fallout to be expected. The estimates of the fatalities, in millions of lives, are given in the table that follows for five alternate targeting methods of the attacker: reading the columns from left to right, the attacker explodes 100%, 75%, 50%, 25%, or 0% of his weapons over areas protected by 100-psi blast shelters, the rest over unprotected areas.

To obtain the first number of the table, one observes that 456 weapons can create a pressure of 100 psi or more over

	100%	75%	50%	25%	0%
Weapons against areas with blast shelters	456	342	228	114	0
Weapons against areas with fallout shelters	0	114	228	342	456
Fatalities (millions) if all weapons explode as aimed	32	48	56	56	53
Fatalities (millions) if two-thirds of weapons explode as aimed	24	33	38	38	37

$4 \times 456 = 1824$ square miles, or about 182 units of the diagram (Fig. 2). This figure then shows that the population in the area covered amounts to about 32 million people. To obtain the figures of the second column, one has to note, first, that the 76 million people who are protected by blast shelters live in the 810 most densely populated squares. Since 114 weapons can cover an area of $114 \times 46 = 5244$ square miles, or 524 squares, the enemy will aim them at the squares numbered 810 to 1334. The total population in these squares is $97\frac{1}{2} - 76 = 21\frac{1}{2}$ million. To this number must be added the fatalities caused by the 342 weapons exploded over areas with blast shelters. These can cover $342 \times 4 = 1368$ square miles, or 137 squares. According to Fig. 2, there are $26\frac{1}{2}$ million people in these squares; so the total fatalities would amount to $21\frac{1}{2} + 26\frac{1}{2} = 48$ million people.

Naturally, the calculation is approximate, but it does give an orientation. More accurate calculations, taking various other factors into account, give values only a little different—about 10% lower. The losses calculated for the case in which both offense and defense spend $10 billion are quite similar. High as the calculated losses are, they are only fractions of those which can be expected in the absence of effective shelters.

The preceding tabulation gives the fatality numbers for an equal expenditure of offense and defense, if this expenditure is around $22½ billion. This is not, however, the point at which the defense expenditure is equal to the cost increase of the offense necessary to maintain the same damage that could be caused in the absence of blast shelters. To cause 56 million fatalities, the attacker has to destroy, even in the absence of blast shelters, 460 unit squares of the diagram for which he needs, in the absence of blast shelters, 100 weapons of 10 Mt. The cost of these is $5 billion, which is small compared with the $22½ billion here under consideration. This calculation assumes that all weapons find their target. The result, however, is insignificantly different under the assumption that only two-thirds of the weapons are effective.

In summary we can say that in the absence of active defense and assuming equal expenditures for offense and civil defense, the offense against the United States could be expected to cause in 1975 the loss of around 50 million lives if it were directed solely against the population. The loss of life would be lower if some active defense were available, if some of the attack were not directed against the population, or if the expenditures for civil defense exceeded those of the offense. The loss of life would be larger if, in the absence of active defense, an attack involving a larger expenditure on weapons than our expenditure on civil defense were undertaken against the U. S. population.

POLICIES OF DETERRENCE AND OF TRUE DEFENSE

Cost effectiveness studies cannot provide a complete comparison of civil defense and of active defense measures with measures of strategic defense (threat of retaliation). The reason is that the comparison must involve some judgment concerning the behavior of enemy leadership, and there is no objective way to arrive at such a judgment. History shows that the leaders of nations can, and often do, act irrationally. Since reliance on strategic defense and the doctrine of assured retaliation presupposes some rationality on the part of the leadership of potential enemies and since this cannot be completely relied upon, it is prudent to provide some positive protection to the people in addition to the threat of revenge. The value of a shelter system can be calculated in terms of lives saved in a nuclear attack of given size; the value of assured retaliation is subject to great uncertainty.

In long wars or during extended periods of tension, evacuations and relocation of the population can greatly reduce the loss of life. The Soviet literature discusses major evacuation plans extensively. Recent studies in the United States point to a variety of circumstances in which evacuation, coupled with the use of improvised shelters, would be the most effective life-saving measure. There are inherent difficulties in planning these actions for purposes of defense because their effectiveness is too dependent on the timing and severity of the attack.

NUCLEAR BLACKMAIL

The mere ability of a nation to wage nuclear war enables it to use threats and ultimata to achieve political advantage over another country. Potential aggressors can be assumed to be familiar with the tactic of repeatedly exacting small concessions under heavy threats. The threat would be particularly effective if it were made in conjunction with the evacuation of major cities and the sheltering of their populations.

The committee believes that the tactic of nuclear blackmail must be seriously considered in relation to civil defense. We can only speculate on what the United States could do if a strong nuclear power demanded concessions, such as U. S. withdrawal from West Berlin or abandonment of the Philippine Islands, and then started to evacuate its cities. If the United States conceded, would the aggressor repeat these tactics? Would U. S. retaliatory power remain effective if the threatening nation through evacuation reduced its population density from 5000 to 1000 per square mile, particularly if the evacuated people were protected by blast shelters? Would the counter threat have to be directed against industrial facilities instead of against masses of people? Would that be an adequate deterrent?

The ability of the United States to extend protection to its people would greatly reduce the likelihood that nuclear blackmail would be attempted against this country; it would also affect the probable success of such blackmail. Some of the committee believe that these effects could be of decisive importance; all of us felt that the underlying questions should be carefully studied.

If protective measures are to decrease the threat of nuclear blackmail, they must not aggravate the crisis. Such aggravation will be avoided if the movement to shelters could take place within the tactical warning time. If this is the case, shelter taking by some will not weaken the enemy's bargaining position; those who have gone to the shelters could have gone there anyway after the attack had been launched. Hence, early shelter taking would not tempt the enemy to precipitate action because it would not weaken his bargaining position.

ABM AND DETERRENCE

The position of the former Secretary of Defense on the question of the relative importance of deterrence and damage-limiting effects, principally the ABM, has been that "capability for 'Assured Destruction' must receive the first call on all our resources and must be provided regardless of the costs and difficulties involved."*

*Statement by Robert M. McNamara before the Joint Senate Armed Services Committee, January 23, 1967.

With regard to the effect that deployment of ABM systems might have, he states that he believes that our active retaliatory forces could and would be strengthened to offset any reduction in damage that an opponent's active defense systems might achieve. He goes on to say, "If our assumption that the Soviets are also striving to achieve an assured destruction capability is correct, and I am convinced that it is, then in all probability all we would accomplish by deploying ABM systems against one another would be to increase greatly our respective defense expenditures, without any gain in real security for either side. . . ."

Although this conjecture about the futility of ABM's may be entirely correct, it is interesting to note that the U. S. reaction to the Soviet ABM system could be viewed in Soviet eyes as a real gain in their own security. Changes in U. S. strategic forces to improve missile penetration aids and to develop new reentry vehicles specifically designed for use against targets heavily defended with ABM systems have been announced. To the extent attention has been turned from encompassing more Soviet targets to attempting to maintain a capability to strike important ones, the Soviets have gained.*

The existence of an ABM forces the attacker to reduce the fraction of missile weight devoted to nuclear explosives if he plans to increase the chances of penetration. Installation of even a modest ABM system increases the effectiveness of shelters because it reduces the total weight of attack possible at a given expenditure.

THE DEVELOPMENT OF PLANNING ASSUMPTIONS

The establishment of sensible protective measures by individual communities requires the definition of the threat likely to be faced in the event of attack. Although precise conclusions on enemy targeting and attack plans are not possible, an important role for federal authorities is to make available to individual communities reasonable and applicable assessments of local risk. Assumptions on levels, types, and objectives of enemy attacks and

---

*The reduction of the total explosive power carried by our own missiles was spelled out by Paul Nitze in his statement to the Joint Committee on Atomic Energy, on November 7, 1967.

the specific degree of blast and fallout protection to afford reasonable prospects for survival, should be developed and made usable for communities and individuals to guide them in planning civil defense actions. Areas around the most likely targets should be made aware that their risks are relatively great and that protection against initial effects is called for; areas far from targets should be advised that their risks will probably involve only fallout.

Finally, we note that in response to growing Soviet capabilities the Department of Defense is providing high-quality blast shelters for our missile systems and is discussing the deployment of NIKE-X for their added protection. The same Soviet capabilities pose a hazard to human lives which will be alleviated to a modest degree by the thin ABM system now in the planning stage. Civil defense measures could lessen the hazard much further.

USAEC Division of Technical Information Extension, Oak Ridge, Tennessee